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[Amalgamating of IS 10617 (Part 1) : 1983,
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भारतीय मानक

वायुरूद्व संपीडको — विशिष्टि

(पहला पुनरीक्षण)

Indian Standard

HERMETIC COMPRESSORS — SPECIFICATION

(First Revision)

ICS 23.140; 97.040.30

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Refrigeration and Air Conditioning Sectional Committee, MED 03

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air Conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1983 in three parts. The three parts are as follows:

Part 1 High temperature application group

Part 2 Medium temperature application group

Part 3 Low temperature application group

The Committee decided to merge IS 10617 (Parts 1 to 3) in a single standard to make it user friendly. This standard has been formulated to assist manufacturers and users as a common guide for performance evaluation and rating of hermetically sealed refrigeration compressors.

In the formulation of this standard, assistance has been derived from the following standards:

DIN 8973 : 1987-06 Motor compressors for refrigerating systems; standard rating conditions; testing; information to be specified on data sheets and identification plates

BS EN 12900 : 1999 Refrigerant compressors — Rating conditions, tolerances and presentation of manufacturer's performance data

ARI 520 : 2004 Performance rating of positive displacement condensing units

UL 984 Standard for safety — Sealed (Hermetic type) motor compressors

ASHRAE standard 23 : 2005 Methods of testing for rating positive displacement refrigerant compressors and condensing units

CECOMAF Standard single stage hermetic and accessible hermetic motor compressors — Standard capacity rating and data covering this rating. Construction de Material Frigorique, France (European Committee of Manufacturers of Refrigeration Equipment).

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is compiled with, the final value, observed or calculated, expressing the rules of the test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

HERMETIC COMPRESSORS — SPECIFICATION

(First Revision)

1 SCOPE

This standard applies to hermetically sealed refrigeration and air-conditioning compressors operating on vapour compression cycle, suitable for low, medium and high temperature applications based on reciprocating, rotary and scroll pump mechanisms.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of the standards. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
5111 : 1993/ ISO 917 : 1989	Testing of refrigerant compressors (*first revision*)
1271 : 1985	Thermal evaluation and classification of electrical insulation (*first revision*)

3 TERMINOLOGY

For the purpose of this standard the following definitions shall apply.

3.1 Refrigeration Compressor — A machine consisting of an electrically driven refrigerant pump housed in a container which is welded or brazed together to form a gas tight shell. The machine cannot be taken apart without cutting open the container housing and has no access to internal moving parts. The electrical windings are exposed to both the refrigerant and the compressor lubricating oil.

3.2 Refrigeration Capacity — It is calculated from the product of mass flow rate and the difference between the enthalpy of the refrigerant vapour entering the compressor suction at a specified temperature and pressure and the enthalpy of the condensed refrigerant liquid at a specified temperature and pressure measured just before the expansion valve as described in **5.1**.The refrigerating effect is expressed in Watts.

3.3 Bubble Point — Refrigerant liquid saturation temperature at a specified pressure. It is the temperature at which the first bubble of vapour forms in liquid refrigerant (saturated liquid).

3.4 Dew Point — Refrigerant vapour saturation temperature at a specified pressure. It is the temperature at which the first droplet of liquid forms in refrigerant vapour (saturated vapour). The evaporating and condensing temperatures should correspond to the mean of bubble and dew points.

4 CLASSIFICATION OF COMPRESSORS

4.1 The compressors shall be classified based on the evaporating range as given in Table 1.

Table 1 Classification of Compressors

Sl No.	Category	Usage	Evaporating Temperature Range °C
(1)	(2)	(3)	(4)
i)	Low back pressure (LBP)	Refrigerating and freezing domestic and commercial applications	–30 to –10
ii)	Commercial back pressure/ Medium back pressure (CBP/MBP)	Commercial applications	–20 to +10
iii)	High back pressure (HBP)	a) Air-conditioning applications	–5 to +13.9
		b) Commercial/Heat pump applications	–23.3 to +12.8

NOTE — In case of zeotropic mixtures, the evaporating temperature and condensing temperature should correspond to its bubble point.

4.1.1 The precise limits of the evaporating temperature range shall be according to manufacturer's specifications.

5 RATING AND TEST CONDITIONS

5.1 Compressor Capacity Rating Test

The capacity of the hermetic compressor shall be evaluated at the specified test conditions as given in Tables 2, 3 and 4.

Table 2 Normal Load Conditions LBP
(*Clause* 5.1)

Sl No.	Item	Unit	Conditions
(1)	(2)	(3)	(4)
i)	Evaporating temperature	°C	– 23.3
ii)	Condensing temperature	°C	54.4
iii)	Ambient temperature	°C	32.2
iv)	Compressor suction gas temperature	°C	32.2
v)	Temperature of sub-cooled liquid	°C	32.2
vi)	External cooling of compressor	Natural convection or any other system specified by the manufacturer	—
vii)	Voltage	V	Rated voltage ± 1 percent
viii)	Frequency	Hz	Rated frequency ± 0.5 percent

NOTE — In case of zeotropic mixtures, the evaporating temperature and condensing temperature should correspond to its bubble point.

Table 3 Normal Load Conditions MBP
(*Clause* 5.1)

Sl No.	Item	Unit	Conditions
(1)	(2)	(3)	(4)
i)	Evaporating temperature	°C	– 6.7
ii)	Condensing temperature	°C	54.4
iii)	Ambient temperature	°C	35.0
iv)	Compressor suction gas temperature	°C	35.0
v)	Temperature of sub-cooled liquid	°C	46.1
vi)	External cooling of compressor	Natural convection or any other system specified by the manufacturer	—
vii)	Voltage	V	Rated voltage ± 1 percent
viii)	Frequency	Hz	Rated frequency ± 0.5 percent

Table 4 Normal Load Conditions HBP
(*Clause* 5.1)

Sl No.	Item	Unit	Conditions
(1)	(2)	(3)	(4)
i)	Evaporating temperature	°C	7.2
ii)	Condensing temperature	°C	54.4
iii)	Ambient temperature	°C	35.0
iv)	Compressor suction gas temperature	°C	35.0
v)	Temperature of sub-cooled liquid	°C	46.1
vi)	External cooling of compressor	Natural convection or any other system specified by the manufacturer	—
vii)	Voltage	V	Rated voltage ± 1 percent
viii)	Frequency	Hz	Rated frequency ± 0.5 percent

NOTES

1 For any other condition of liquid sub-cooling, encountered in actual test, test results shall be corrected by calculation, back to the rated figure.

2 The manufacturer shall specify the maximum and minimum operating pressure and temperature conditions for the safe operation of the compressor.

6 TESTING

The compressor tests shall be divided into two categories:

a) *Type Tests* — To be performed once a year or at a frequency as agreed to between the manufacturer and the supplier; and

b) Routine tests.

6.1 Type Tests

6.1.1 *Refrigeration Capacity Test*

6.1.1.1 The determination of refrigeration capacity of hermetic compressors shall be carried out by any of the methods and the test appliances given in IS 5111 depending on the test equipment available at manufacturer's works. The observed capacity values when measured under stabilized conditions, shall be within ± 5 percent of the declared values.

NOTE — Reference to IS 5111 has been made only for purposes of selection of test method or procedure or equipment and not for any test conditions mentioned there.

6.1.2 *Startability Test*

6.1.2.1 The hermetic compressors have following types of starting methods:

Single Phase	*Types*
RSIR	Resistance start induction run
CSIR	Capacitor start induction run
PSC	Permanent split capacitor
CSR	Capacitor start and run
PTCIR	PTC start induction run
PTCCR	PTC start capacitor run
Three phase	Star/Delta

For any of the above category, the compressor shall be able to take start at the lowest voltage range and come up to the stabilized running conditions.

The nominal voltage punched or printed on the marking plate ±10 percent shall be the operating voltage range. The compressor should start and run when minimum voltage is applied with conditions as specified in Table 5.

Care must be taken during the start test to ensure that the power supply system is properly sized for the load of Locked Rotor Amperes (LRA).

6.1.2.2 *Start test conditions*

The start test to be conducted at the pressures equal to the saturation temperatures listed in Table 5.

Table 5 Start Test Conditions
(*Clauses* 6.1.2.1 *and* 6.1.2.2)

Sl No.	Item	LBP	MBP	HBP
(1)	(2)	(3)	(4)	(5)
i)	Saturated evaporating temperature, °C	15	32.2	46.1
ii)	Saturated condensing temperature, °C	15	32.2	46.1

NOTE — Refer to charts of refrigerant properties for saturation temperature and corresponding pressures.

6.1.2.3 *Cold startability test*

The cold start test shall be carried out with the above conditions with motor temperature at ambient. The compressor shall start at 85 percent of the rated voltage (no load voltage). If the compressor does not start, raise the voltage and determine where a successful start can be attained.

6.1.2.4 *Hot startability test*

Repeat the above for three times after assessing minimum possible start voltage when motor is under hot condition (80°C to 93°C). Minimum possible start voltage shall be 180 V.

6.1.3 *Locked Rotor Test with Accessories*

The compressor along with its specified electrical accessories shall be subjected to locked piston for locked rotor test at rated voltage at an ambient temperature not exceeding 35°C until stabilization in winding temperature is achieved.

The peak and stabilized winding temperatures under this test shall not exceed the limits as specified by the manufacturers. The compressor holding refrigerant pressure shall be as specified by the compressor manufacturer.

6.1.4 *High Voltage Test*

The compressor shall be able to withstand 1.5 kV for 1 min without breakdown. This test shall not be repeated on the same compressor.

6.1.5 *Insulation Resistance Test*

The insulation resistance between the electric circuits included in the compressor and earthed metal parts, when measured at normal room temperatures voltage is 500 V d.c., the resistance shall be not less than 50 MΩ. This test shall be conducted after high voltage test.

6.1.6 *Pneumatic Test of Shell*

The shells shall be tested pneumatically (dry air/ nitrogen) at a test pressure of 1MPa (gauge) and shall not show any leakage.

6.1.7 *Bursting Test*

Representative samples of the shell shall be subjected to an internal hydrostatic pressure till it bursts. The nominal hoop stress corresponding to the pressure at which destruction occurs shall be calculated from the formula:

$$f_b = \frac{P_b D_i}{2t}$$

where

f_b = nominal hoop stress at which destruction occurs, in MPa;

P_b = internal hydrostatic pressure at which shell bursts, in MPa;

D_i = nominal original internal diameter of the shell, in mm; and

t = minimum agreed finished thickness, as specified on the drawing (including corrosion allowance, if any), in mm.

6.1.7.1 The value of f_b shall be not less than 0.95 of the minimum specified tensile strength of the material of the cylinder.

6.1.7.2 The shell shall burst without fragmentation.

6.2 Holding Charge

All compressors shall have a positive charge of 0.3 kg/cm^2 to 1.0 kg/cm^2 of dry air/nitrogen having a dew point not more than -40°C or as per the mutual agreement between the supplier and the buyer.

6.3 Routine Tests

Routine tests shall consist of the following tests as per the mutual agreement between the supplier and the buyer:

a) High voltage test at 1.5 kV for 1s;

b) Insulation test at 500V d.c.; the insulation resistance shall be not less than 50MΩ; and

c) Shell leakage test, at a pressure corresponding to 1.1 times P_{Max} where P_{Max} is the maximum operating pressure inside the shells, as specified by the manufacturer.

NOTE — Avoid high voltage repeat test on the same compressor.

7 COMPRESSOR EFFICIENCY LABELLING

7.1 COP Definition

The compressor efficiency termed as coefficient of performance (COP) is defined as the ratio of capacity, in Watts, to the power consumption at nominal voltage and frequency as per **5.1**.

7.2 EER Definition

The compressor efficiency termed as energy efficiency ratio (EER) is defined as the ratio of capacity, in kcal/h, to the power consumption at nominal voltage and frequency as per **5.1**.

7.3 Efficiency Labelling

The manufacturer may label the compressor as per Tables 6, 7 and 8 at rated conditions as per **5.1**.

Table 6 Efficiency Labelling — LBP Condition

Sl No.	Classification	Class I	Class II	Class III
(1)	(2)	(3)	(4)	(5)
i)	Capacity Range: *W*	88-249	88-249	88-249
ii)	COP (W/W) EER (kcal/Wh)	1.05-1.17 (0.91-1.00)	1.17-1.32 (1.01-1.13)	1.32-1.61 (1.14-1.39)
iii)	Energy stamping	Energy efficient	High energy efficient	Super energy efficient

8 COMPRESSOR PROTECTION SYSTEM

The compressor should have built in protection system. It may be bi-metallic thermal overload protection (OLP) or electronically controlled protection system. The OLPs can be either internal to the compressor or placed externally. The compressor should be capable of withstanding the overload on calorimeter tests as given in Table 9. The OLP should not trip during the overload test conditions as specified in Table 9 for 2 h running.

Table 7 Efficiency Labelling — CBP/MBP Condition
(*Clause* 7.3)

Sl No.	Classification	Class I	Class II	Class III
(1)	(2)	(3)	(4)	(5)
i)	Capacity Range: *W*	220-1 172	220-1 172	220-1 172
ii)	COP (W/W) EER (kcal/Wh)	1.41-1.61 (1.21-1.39)	1.61-1.76 (1.39-1.51)	1.76-2.34 (1.51-2.02)
iii)	Energy stamping	Energy efficient	High energy efficient	Super energy efficient

Table 8 Efficiency Labelling — HBP Condition
(*Clause* 7.3)

Sl No.	Classification	Class I	Class II	Class III
(1)	(2)	(3)	(4)	(5)
i)	Capacity Range: *W*	3 517-10 551	3 517-10 551	3 517-10 551
ii)	COP (W/W) EER (kcal/Wh)	2.75-2.90 (2.37-2.49)	2.93-3.08 (2.52-2.65)	3.09 and above (2.66 and above)
iii)	Energy stamping	Energy efficient	High energy efficient	Super energy efficient

9 WINDING TEMPERATURE

The winding temperature under the overload conditions as per Table 9 with rated voltage, shall not exceed the values specified within the permissible limits of insulation as per IS 1271. The overload test to be further continued by reducing the voltage from rated voltage in steps of 4 percent ± 1percent volts until OLP trips. Next step of voltage to be applied when the compressor reaches its equilibrium. The winding temperature when the OLP trips shall not exceed 150°C.

10 LOCKED ROTOR TEST

The compressor with overload protection system shall undergo locked rotor testing. The locked rotor condition is obtained by blocking the movement of rotor on specimen compressor. The compressor should be charged with refrigerant and oil; the standing pressure should approximately the standing pressures of appliance. The nominal voltage is to be applied when the compressor is kept under environment of 35 °C. The system shall be tested for 15 days or for 2 000 cycles, whichever is the longer.

At the end of the test,

a) winding temperature shall not exceed 150 °C for Class ‘B’ insulated hermetic motors;

Table 9 Overload Test Conditions
(*Clauses* 8 *and* 9)

Sl No.	Application Category	Evaporation Temperature	Condensation Temperature	Motor-Compressor Ambient Temperature	Return Gas Temperature
		°C	°C	°C	°C
(1)	(2)	(3)	(4)	(5)	(6)
i)	Low back pressure	– 15	+65	+43	+43
ii)	Medium back pressure	0	+65	+43	+25
iii)	High back pressure	+12	+65	+43	+25

b) shell temperature shall not exceed 150°C; and

c) accessories shall be under operable conditions.

11 PAINTING AND PACKING

Painting (colour, type, etc) and mode of packing shall be according to the manufacturer's specifications.

12 SPECIFICATION

Compressor specification literature may include the following for facilitating selection of compressor by buyer:

a) Type — Hermetic;

b) Displacement/revolution;

c) Refrigerant type;

d) Application group/range of evaporating temperature;

e) Refrigeration capacity at rating conditions in kcal/h;

f) Electrical characteristics, such as nominal voltage, voltage range, phases, frequency and nominal input power;

g) Method of cooling;

h) Starting methods;

j) Wiring diagram with details of start relay/ capacitor, run capacitors, overload protectors, etc;

k) External physical dimensions and pipe connections;

m) Compressor weight; and

n) Quantity of oil and its grade.

13 MARKING

13.1 The compressor shall have the following information marked on a nameplate in a permanent and legible manner in a location, where it is accessible and visible:

a) Name and address of manufacturer;

b) Type or model number and serial number of the unit;

c) Month and year of manufacture;

d) Rated voltage, phase and frequency;

e) Locked rotor current;

f) Power consumption at rated conditions; and

g) Refrigerant.

13.2 BIS Certification Marking

Each compressor may also be marked with the Standard Mark.

13.2.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made there under. The details of conditions under which a license for the use of Standard Mark may be granted to the manufacturers or the producers may be obtained from the Bureau of Indian Standards.

ANNEX A
(*Foreword*)

COMMITTEE COMPOSITION

Refrigeration and Air-Conditioning Sectional Committee, MED 03

Organization	*Representative(s)*
Indian Institute of Technology, New Delhi	Prof Dr Sanjeev Jain (***Chairman***)
All India Air Conditioning and Refrigeration Association, New Delhi	Shri S. K. Sharma
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Scientist 'E' (MED), BIS

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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